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Supporting Quality of Service for Internet Applications

A thesis presented for the degree of

Master of Science Research

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Certificate of Authorship/Originality

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of the requirements for a degree, except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of candidate

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Publications

H. T. Phan and D. B. Hoang, "A New QoS Architecture Supporting Resources Discovery, Admission and Congestion Controls", *IEEE International Conference on Information Technology and Applications (ICITA05)*, 04-07 July 2005.

H. T. Phan, D. B. Hoang, and B. Yousef, "Performance Analysis of FICC-DiffServ Architecture", *IEEE Conference on Local Computer Networks (LCN05)*, 15-17 November 2005.

H. T. Phan and D. B. Hoang, "Extension of BGP to support multi-domain FICC-Diffserv architecture", *IEEE Conference on Advanced Information Networking and Applications (AINA06)*, 18-20 April 2006.

Declaration

The work in this thesis is based on research carried out with the Advanced Research in Networking Group (ARN), the Department of Computer Systems, Faculty of Information Technology, University of Technology Sydney, Australia. No part in this thesis has been submitted elsewhere for any other degree or qualification and it is all my own work, unless referenced to the contrary in the text.

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List of Acronyms

ABI	Available Bandwidth Index
AC	Admission Control
ACR	Allowed Class Rate
AF	Assured Forwarding
AFR	Arrival Flow Rate
AS	Autonomous System
BB	Bandwidth Broker
BGP	Border Gateway Protocol
CL	Controlled Load
COS	Class of Service
CPU	Central Processing Unit
CSFQ	Core-Stateless Fair Queuing
DiffServ	Differentiated Services
DSCP	DiffServ Code Point
EF	Expedited Forwarding
ER	Explicit Rate
FEC	Forwarding Equivalence Class
FER	Per-Flow Explicit Rate
FIAC	Fair Intelligent Admission Control
FICC	Fair Intelligent Congestion Control
FIFO	First-In First Out
GS	Guarantee Services
IANA	Internet Assigned Numbers Authority
IETF	Internet Engineering Task Force
IGP	Interior Gateway Protocol
IntServ	Integrated Services
IP	Internet Protocol
ISP	Internet Service Provider
LDP	Label Distribution Protocol

LSP	Label Switch Path
LSR	Label Switch Router
MACR	Mean Allowed Class Rate
MAFR	Mean Arrival Flow Rate
MED	Multi Exit Disc (BGP Attribute)
MIB	Management Information Base
MPLS	MultiProtocol Label Switching
NE	Network Elements
NLRI	Network Layer Reachability Information
OSPF	Open Shortest Path First
PHB	Per-hop Forwarding Behaviour
P2P	Peer-to-Peer
QoS	Quality of Service
QPPB	QoS Policy Propagation via BGP
RD	Resource Discovery
RED	Random Early Drop
RFC	Request For Comment
RIB	Route Information Base
RIP	Routing Information Protocol
RSVP	Resource Reservation Protocol
RTT	Round-Trip Time
SLA	Service Level Agreement
TCP	Transmission Control Protocol
TOS	Type of Service
UDP	User Datagram Protocol
WRR	Weighted Round Robin

Abstract

Regarding the dominance of IP applications and the requirement of providing quality of service for users, it is critical to provide an scalable network architecture capable of supporting sufficient Quality of Service (QoS). Of the two network models (Integrated Services and Differentiated Services) approved by the Internet Engineering Task Force (IETF) [1, 2], the differentiated service model has gained wider acceptance because of its scalability.

Differentiated Services (DiffServ) QoS architecture is scalable but inadequate to deal with network congestion and unable to provide fairness among its traffic aggregates. Recently, IETF has recommended additional functions including admission control and resource discovery to enhance the original DiffServ [2].

In this thesis, we propose a new framework based on DiffServ. The new architecture, called Fair Intelligent Congestion Control DiffServ (FICC-DiffServ), applies the FICC algorithm and control loop to provide fairness among traffic aggregates and control congestion inside DiffServ networks. The augmented architecture is realisable within the existing IP network infrastructures. Simulation results show that the FICC-DiffServ performs excellently in terms of guaranteed fairness, minimised packet delay and jitter, as well as being robust to traffic attributes, and being simple to implement.

Moreover, providing end-to-end QoS for Internet applications presents difficult problems, because the Internet is composed of many independently administrative domains called Autonomous Systems. Enabling end-to-end QoS, negotiations between domains is then crucial. As a means of negotiations, inter-autonomous system QoS routings play an important role in advertising the available network resources between domains. In this thesis, the Border Gateway Protocol (BGP) is extended to provide end-to-end QoS. The BGP is selected for two reasons: (1) BGP is an inter-domain routing protocol widely used on the Internet and (2) the use of attributes attached to routes makes BGP be a powerful and scalable inter-domain routing protocol.

For end-to-end QoS, a completed framework includes a FICC-DiffServ in each domain, an extended BGP between domains and an admission control at the edge router. Via simulation, we demonstrate the reliability of the BGP-extended architecture, including route selection policy and overhead reduction issues.